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# APPLICATION

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# PORTABLE BREAKWATER

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to systems and devices for attenuating or dissipating wave energy. More particularly, the present invention relates to portable systems and devices deployable in a body of water between generated waves and a shoreline to be protected from wave impact.

### 2. Description of Related Art

Anyone living along a shoreline, whether at the ocean, along a river, or beside a lake or pond, is familiar with erosion. While some processes of erosion are subtler than others, waves produce the most apparent and rapid shoreline erosion. Underwater currents or external weather events may generate waves. In addition, human activities, such as boating, produce sporadic but particularly devastating erosive waves. The on going and apparently increasing interest in the use of watercraft, particularly in confined bodies of water, indicates that shoreline erosion problems will remain and may increase.

The owners of shoreline property have to date had little recourse to prevent the man-made waves and certainly no recourse in regard to naturally generated waves. As a result, periodic and costly repair of the shoreline is generally seen as the only way to respond to the impact of erosion. Of course, it is possible to introduce breakwater systems formed of boulders, rocks, timbers, concrete structures, and the like into the water. The breakwater is intended to do as its name suggests: break up the flow of the water, whether in the form of a wave or an undercurrent, as it approaches the shoreline. That is done on occasion and typically seen in oceanside locations. However, such structures are permanently set in a fixed position

and they tend to disrupt the natural appearance of the shoreline. Moreover, they ordinarily fall under the purview of governmental authorities that place breakwaters for the intended common good of the general public, a particular group, or as part of a larger plan or project. Although private individuals may place fixed breakwaters in the vicinity of their shorelines, assuming they have the right to put such structures in the water, they can be quite expensive. In addition, they may not be able to block all incoming waves, dependent on changes in the direction of the waves. Moreover, they have a tendency to disrupt the natural appearance and/or usage of the shoreline. It is also to be noted that these structures are quite rigid and therefore deflect or transfer the wave energy from one location to another. That deflected energy may simply cause damage at another location.

Therefore, what is needed is a breakwater system or device that is suitable for dissipating or attenuating the energy associated with waves coming into a shoreline. Further, what is needed is such a breakwater system or device that is relatively inexpensive and simple to install in comparison to the introduction of existing fixed breakwater structures. Yet further, what is needed is a breakwater system that absorbs wave energy rather than simply deflecting it. Also, what is needed is a breakwater system that is relatively portable such that it may be moved to a plurality of sites as desired by the user. Moreover, what is needed is a breakwater system that minimizes the disruption to the appearance and/or use of the natural shoreline.

SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide a breakwater system and related method to dissipate or attenuate the energy associated with waves coming into a shoreline. It is also an object of the present invention to provide a breakwater system that is relatively inexpensive and easy to install in comparison to the introduction of existing fixed breakwater structures. It is a further object of the present invention to provide a portable breakwater system that may be deployed to a plurality of

sites as desired by the user. Yet further, it is an object of the present invention to provide a breakwater system that absorbs rather than deflects wave energy. Still further, it is an object of the present invention to provide a breakwater system that minimizes the disruption to the appearance and/or use of the natural shoreline.

These and other objects are achieved with the present invention, which in one embodiment is a portable breakwater system that is installed in the water in proximity to a shoreline region to be protected. The system includes a base plate that is designed to rest on the floor of the body of water where the wave action is to be dissipated. Although the system of the present invention may be used in any sort of water, it is particularly advantageous in lakes and ponds because these bodies of water tend to have less fluctuation of water levels and less extreme storm conditions than oceans. The base plate is part of a larger support subsystem that also includes sites to selectably locate thereon stabilizing units such as one or more anchors or weights. The stabilizing units and the base plate act to maintain the entire structure in position through expected water movement conditions. The support structure may be moved to one or more positions of interest and a plurality of support structures may be placed adjacent to one another.

The support system also includes frame mounts for receiving a frame. The frame in turn acts as the retainer mechanism for locating a dissipation screen or curtain in a variable position at, below, and above the water surface. The screen or curtain acts as a wave-dissipating device in that it is fabricated and formed to absorb, rather than deflect or transfer, energy. The frame is preferably configured to retain an upper portion of the curtain flat on a smooth water body surface. When wave action begins, the frame preferably enables movement of the upper portion of the curtain to a substantially completely upright position such that the wave energy, embodied in wave height, is diminished. The water associated with that wave action is

allowed to pass around the curtain but with a substantial portion of its forward-projecting energy absorbed by the curtain rather than the shoreline.

The combination of the portable frame and the absorbing curtain create a wave dissipation system that may be set up where desired without great difficulty and relatively little expense. It is contemplated that the system will address the problems of soil and sediment erosion related to direct, oblique, or longshore waves, wakes, and/or water current action that flows in shallow and/or fluctuating water levels. These and other advantages of the invention will become apparent upon review of the following description and the drawings.

## DESCRIPTION OF THE DRAWINGS

The subject matter that is regarded as the invention is particularly pointed out and distinctly claimed in the concluding part of the specification. The invention, however, may be best understood by reference to the following description taken in conjunction with the accompanying drawing figures in which:

FIG. 1 is a perspective representation of the portable breakwater system of the present invention shown in context.

FIG. 2 is a front view of a portion of the portable breakwater system of the present invention.

FIG. 3 is a cross-sectional view of a portion of a weight of the present invention.

FIG. 4 is a side view of a portion of the portable breakwater system of the present invention.

FIG. 5 is a side view of an offset hinge used in a support member of the present invention.

FIG. 6 is a cross-sectional detailed view of the weighting mechanism for the optional frame top return of the present invention.

FIG. 7 is a perspective representation of a second embodiment of a portable breakwater system.

FIG. 8 is a front view of a portion of the portable breakwater system of FIG. 7.

FIG. 9 is a cross-sectional detailed view of a telescoping post arrangement for the portable breakwater system of FIG. 7.

FIG. 10 is a front view of a third embodiment of a portable breakwater system.

FIG. 11 is an enlarged, detailed view of a portion of the portable breakwater system of FIG 10, showing a curtain attachment sleeve.

FIG. 12 is an exploded view of the attachment sleeve of FIG. 11.

DETAILED DESCRIPTION OF THE INVENTION

A portable breakwater system **10** of the present invention is shown in FIG. 1. The system **10** includes an attenuation or wave-impact curtain **12** and a curtain support assembly **14**. The system **10** is positionable on a floor **16** of a body of water **18**. It may be used to absorb the energy of one or more inbound waves **20** from impacting a shoreline **22** in order to minimize erosion of the shoreline **22**.

With reference to FIGS. 1 and 2, the support assembly **14** includes a first support member **24** and a second support member **26** having the curtain **12** supported between them. Each of the first support member **24** and the second support member **26** includes a frame base plate **28** and a frame assembly **30** extending upwardly from the base plate **28**. The frame base plates **28** preferably include one or more securing cleats **31** to stabilize

the base plate **28** on the underlying floor **16**, particularly when that surface is rough or uneven in some way. The base plates **28** may be fabricated of any suitable material of sufficient density and capable of surviving underwater conditions. Further, the base plate **28** may be formed with perforations in a surface thereof in order to allow underwater currents to pass therethrough with minimal interference.

Each of the base plates **28** further includes a central frame-receiving port and, optionally, one or more post-receiving ports positioned on an upper base surface **29**. The central port may be threaded or otherwise configured to removably receive a first frame section **32** of the respective frame assemblies **30**. That first frame section **32** may be fabricated of a non-metallic material or a metallic material and may be hollow or solid. It is designed to be detachably affixed to the base plate **28**. Alternatively, the first frame section **32** can be fixedly attached to the base plate **28**.

Each support member **24** and **26** further includes one or more weights **36** stacked thereon for the purpose of maintaining the respective base plates **28** in place and ensuring that the entire system **10** remains in place where positioned on the floor **16** during the variety of environmental conditions to be experienced. The weights **36** are preferably of a donut shape so that they may be mounted over the first frame section **32**. A locking or hitch pin **34** is inserted through the first frame section **32** just above the uppermost weight **36** to prevent relative movement between the first frame section **32** and the stack of weights **36**. Of course, the weights **36** may be formed in alternative shapes provided they serve the function of anchoring the system and its components in place where desired.

A first set of weights **36** substantially centered on the first frame section **32** defines the location of that portion of the first support member **24**. A second set of weights **36** substantially centered on the other first frame section **32** defines the location of that portion of the second support member **26**. Although shown as a stepped set of four weights in FIG. 2, the number

and size of weights **36** used is selectable as a function of the size of the system **10** and the conditions experienced in the body of water **18**. Perimeter base weights **40** preferably positioned on perimeter posts **42** provide additional weight to the respective support members **24**,**26** as desired and required. Protective post safety caps **44** may be used to reduce the impact of any contact with upper surfaces of the posts **42**. The safety caps **44** may be made of rubberized or other suitable material and may be colored with some type of warning color.

As illustrated in FIG. 3, one embodiment of the weights **36** or **40** are preferably formed with a hollow casement body **37** having a fill port **39** for receiving a weight-providing material **41** that may be something substantially permanent, such as concrete. A casement cap **43** is threadingly engaged to the threaded fill port **39** to enclose the material **41** therein. Alternatively, the cap **43** may be removed to allow water to fill the casement body **37**. The casement body **37** may be made of any suitable material, including plastic. As another alternative, the weights **36** or **40** could comprise a complementary pair of hollow, half donut shaped bodies filled with a weight-providing material and then snapped or otherwise joined together.

With continuing reference to FIGS. 1 and 2, each of frame assembly **30** further includes an intermediate frame section **46** detachably connected to the first frame section **32**. The intermediate section **46** acts as the primary structural member for retaining the impact curtain **12** to be described herein. It is preferably threadingly engaged at a bottom end thereof to the top end of the first frame section **32**. The intermediate frame section **46** may be of any selectable length dependent upon the depth of the body of water **18** where it is positioned on the floor **16**. It may be formed of a material similar to that used for the first frame section **32**. The first frame section **32** and the intermediate frame section **46** jointly define a bottom frame section. Alternatively, the first and intermediate frame sections could comprise a single, integral member defining the bottom frame section.

Each support member **24,26** may also include one or more supplemental base plates **38** disposed on the floor **16** of the body of water 18, at a location remote from the primary base plate **28**. The supplemental base plates **38** are preferably anchored to the floor **16** by one or more weights in the same manner as the primary base plates **28**. A wire, cable or rod 45 extends from each supplemental base plate **38** to the corresponding first or intermediate frame section **32,46** to further secure the support member **24,26**.

The remaining portion of each of the respective support members **24,26** is a top frame section **48**, preferably formed of the same material used to make sections **32** and **46**. The top frame section **48** is preferably capped with a protective safety cap **50** much like the post safety cap **44**. A useful aspect of the present invention is the coupling of the top frame section **48** to the intermediate frame section **46**. In order to ensure that the system **10** performs its desired function when waves **20** exist while keeping the curtain **12** substantially out of sight when the water **18** is calm, the top frame section **48** is hinged to the intermediate frame section **46**. As best seen in FIG. 4, this configuration permits pivoting of the top frame section **48** so that that portion of the two members **24,26** lays over the water **18** during calm conditions (shown in solid lines in FIG. 4) and freely rises when forced by wave or wake action (shown in dashed lines in FIG. 4).

Referring to FIG. 5, an upper region **52** of each of the intermediate frame sections **46** is formed with an angled recess **54** and includes a paired eyelet flange **56**. Relatedly, a lower region **58** of top frame section **48** includes a mirror image angled recess **60** that matches in an opposing manner the angled recess **54** of region **52**. The lower region **58** also includes a ported hinge flange **64** designed to fit within the space between the paired eyelets of flange **56** in a pivoting manner. A removable hinge pin **66** may keep the two frame sections **46,48** detachably connected together. Moreover, the hinge pin **66** allows the top frame section **48** to pivotally move with respect to the intermediate frame section **46**, which

remains in a fixed position due to its coupling to the first frame section **32**. It can be seen in FIG. 5 that the angled recesses **54** and **60** of the respective frame sections do not extend completely. Instead, they are truncated such that upper region **52** includes a truncation face **68** upon which lower region **58** bottoms out when the top frame section **48** is in its most upright position. This configuration prevents the curtain **12** from falling back towards the shore under the load of the waves **20** and become unable to provide wave attenuation capability. This function could alternatively be accomplished with a chain, cable or the like connected between the two frame sections **46, 48**. While a variety of angles of the angled recesses **54**,**60**, may be contemplated, it has been observed that an angle of about 20° is suitable.

As seen in FIG. 4, the top frame section **48** does not become completely vertical in its most upright position with this hinge configuration. This arrangement facilitates returning the curtain **12** to the lower position after the wave **20** passes. Although it is anticipated that the weight of the curtain **12** may be sufficient to ensure that when the frame connecting configuration of FIG. 5 is employed the curtain **12** will lay over during calm water conditions, the top frame **48** may be modified to accomplish that. Specifically as shown in FIG. 6, when a hollow material is employed to form the top frame section **48**, a frame return weight **70** may be deployed therein, preferably above the frame section's center of mass. A tension bolt **72** may be threadingly employed within a frame port **74** to maintain the return weight **70** in position within the frame section **48**.

Returning to FIGS. 1 and 2, the attenuation or impact curtain **12** includes a primary impact zone **76**, a first frame attachment section **78** and a second frame attachment section **80**. The attachment frame sections **78**,**80** are preferably looped regions extending the entire height of the curtain **12** and are configured to be placed around the frame sections **48**,**46**. When so deployed, the support members **24**,**26** position the curtain **12** at its opposing ends in a substantially vertical orientation.

The curtain **12** may be fabricated of a substantially non-metallic material having energy absorbing qualities, such as neoprene. The looped sections may be made by permanently threading the curtain material onto itself or employing some type of releasable attachment mechanism, such as a hook-and-loop attachment. When the frame return hinge arrangement of FIG. 5 is employed, the curtain **12** preferably includes frame ports **82** to allow the top frame section **48** to move with minimal stretching of the curtain **12**.

The curtain **12** may also include one or more flotation devices **84** deployed along its upper surface to keep the curtain open as shown with minimal sagging. The flotation devices **84** may be foam materials coupled along the upper edge of the curtain **12** by rope or string **86** through grommeted eyelets **88** incorporated into the curtain **12**. Alternatively, the flotation devices **84** could be retained inside of sleeves formed along the upper edge of the curtain **12**. The curtain **12** may further be fixed in position using underwater curtain weights **90** periodically spaced on the floor **16**. As with the flotation devices **84**, the curtain weights **90** may be coupled to the lower edge of the curtain **12** by weight rope or string **92** connected to curtain weight grommeted eyelets **94**. It is to be noted that the curtain **12** may include periodic perforations therein to allow a portion of the water **18** and waves **20** to pass therethrough.

Turning now to FIGS. 7 and 8, a second embodiment of a portable breakwater system **110** is shown. Like the first embodiment, the breakwater system **110** includes an attenuation or wave-impact curtain **112** supported between a first support member **124** and a second support member **126** disposed on the floor **116** of a body of water **118**. The first support member **124** and the second support member **126** both include a primary base plate **128** and a frame assembly **130** extending upwardly from the base plate **128**. The frame base plates **128** preferably include one or more securing cleats **131** to stabilize the base plate **128** on the underlying floor **116**, particularly when that surface is rough or uneven in some way. The base

plates **128** may be fabricated of any suitable material of sufficient density and capable of surviving underwater conditions. Further, the base plate **128** may be formed with perforations in a surface thereof in order to allow underwater currents to pass therethrough with minimal interference.

Each frame assembly **130** includes a bottom frame section **132** extending upwardly from the base plate **128**. The bottom frame section **132** may be fabricated of a non-metallic material or a metallic material and may be hollow or solid. It is designed to be detachably affixed to the base plate **128**.

Each support member **124,126** further includes one or more weights **136** stacked thereon for the purpose of maintaining the respective base plates **128** in place and ensuring that the entire system **110** remains in place where positioned on the floor **116** during the variety of environmental conditions to be experienced. The weights **136** are preferably of a donut shape so that they may be fixed in position about the bottom frame section **132**. A locking or hitch pin **134** is inserted through the first frame section **132** just above the uppermost weight **136** to prevent relative movement between the bottom frame section **132** and the stack of weights **136**. The weights **136** may be formed in alternative shapes provided they serve the function of anchoring the system and its components in place where desired.

Perimeter base weights **140** are preferably positioned on perimeter posts **142** to provide additional weight to the respective support members **124,126** as desired and required. Protective post safety caps **144** may be used to reduce the impact of any contact with upper surfaces of the posts **142**. The safety caps **144** may be made of rubberized or other suitable material and may be colored with some type of warning color. The weights **136,140** are similar to those in the first embodiment. Although not shown in FIG. 7, supplemental base plates like those described above can also be employed.

Each frame assembly **130** further includes a top frame section **146** disposed over the bottom frame section **132** in a telescoping manner. That is, the top frame section **146** is a hollow member that slides longitudinally over the bottom frame section **132**. Referring to FIG. 9, the top frame section **146** has an internal lip **147** formed on its lower end, and the bottom frame section **132** has an external lip **133** formed on its upper end. The two lips **133,147** cooperate to prevent the top frame section **146** from sliding off the bottom frame section **132**. The top frame section **146** is preferably capped with a protective safety cap **150** much like the post safety caps **144**.

The attenuation or impact curtain **112** includes a primary impact zone **176**, a first attachment section **178** and a second attachment section **180**. The attachment sections **178,180** are preferably looped regions extending the entire height of the curtain **112** and are configured to be placed around the top frame sections **146** of the respective support members **124,126**. The support members **124,126** thus position the curtain **112** at its opposing ends in a substantially vertical orientation. The curtain **112** is attached entirely to the top frame sections **146** so as to rise and fall with the top frame sections **146** relative to the bottom frame sections **132**.

The curtain **112** may be fabricated of a substantially non-metallic material having energy absorbing qualities, such as neoprene. The attachment sections **178,180** may be made by permanently threading the curtain material onto itself or employing some type of releasable attachment mechanism, such as a hook-and-loop attachment. The curtain **112** may also include one or more flotation devices **184**. The flotation devices **184** may be foam materials coupled along the upper edge of the curtain **112** by rope or string **186** through grommeted eyelets **188** incorporated into the curtain **112**. Alternatively, the flotation devices **184** could be retained inside of sleeves formed along the upper edge of the curtain **112**. It is to be noted that the curtain **112** may include periodic perforations therein to allow a portion of the water **118** and waves **120** to pass therethrough.

In operation, the flotation devices **184** hold the upper edge of the curtain **112** at the level of the water **118** with minimal sagging. During calm conditions, this means that the top frame sections **146** and curtain **112** are relatively low with respect to the bottom frame sections **132** (as depicted in solid lines in FIG. 8). When a wave **120** approaches, the flotation devices **184** rise with the wave pulling the curtain **112** upward as well. The telescoping top frame sections **146** slide upwardly with respect to the bottom frame sections **132**, allowing the curtain **112** to freely rise so as to be in position to attenuate the wave **120** (as depicted in dashed lines in FIG. 8). Because the entire curtain **112** rises and falls with the top frame sections **146**, the curtain weights **90** that are employed in the first embodiment are not used in the second embodiment.

Referring to FIG. 10, a third embodiment of a portable breakwater system **210** is shown. The breakwater system **210** of this embodiment includes at least one attenuation or wave-impact curtain **212** that is supported on pre-existing underwater structure located in a body of water **218**. In the example illustrated in FIG. 10, the pre-existing underwater structure is a dock **208**. Preferably, the dock **208** can be an L-shaped structure that includes a first section (not shown) that extends outward from the shore of the body of water **218**, and a second section **209** that extends perpendicularly from the distal end of the first section. As such, the second section **209** is oriented substantially parallel to the shore. It should be noted that the curtain **212** is not limited to use with L-shaped dock structures, but can be used with a wide variety of underwater structures.

The dock **208** includes a plurality of underwater support members, such as poles or posts, that extend upward from the floor **216** of the body of water **218** to support the above-water portion of the dock **208**. First and second ones **224, 226** of such support members are shown in FIG. 10 for supporting the second dock section **209**. The first and second support

members **224, 226** may be made of any material suitable for prolonged exposure to water.

In one possible configuration of this third embodiment, an attenuation curtain **212** is supported between the first and second support members **224, 226**. This is accomplished using a first attachment sleeve **278** attached to a first end of the curtain **212** and a second attachment sleeve **280** attached to the opposite end of the curtain **212**. The first attachment sleeve **278** is slidingly mounted on the first support member **224** below the above-water portion of the dock **208**, and the second attachment sleeve **280** is slidingly mounted on the second support member **226** below the above-water portion of the dock **208**. With this arrangement, the curtain **212** freely rises and falls in response to wave or wake action.

As shown in FIGS. 11 and 12, the first attachment sleeve **278** includes a pair of brackets **295** arranged on opposite sides of the first support member **224** and the curtain **212**. Specifically, each bracket **295** has a central indented section **296** and first and second planar flanges **297, 298** formed on respective sides thereof. The brackets **295** are arranged so that the two indented sections **296** enclose the first support member **224**, with the curtain **212** being sandwiched between the two first flanges **297**. The corresponding first flanges **297** are connected by any suitable fasteners such as nuts-and-bolts **299**, and the corresponding second flanges **298** are similarly connected by suitable fasteners **299**. Thus, the two brackets **295** are connected together so as to attach the sleeve **278** to the curtain **212** and allow the sleeve **278** and curtain **212** to slide relative to the first support member **224**. It should be understood that the indented sections **296** are not limited to the semi-circular configuration shown in FIGS. 11 and 12 and can have other recessed configurations including non-circular curvatures, rectangular recesses, and the like. The second attachment sleeve **280** is substantially the same as the first and is therefore not described in detail here.

The curtain **212** may also include one or more flotation devices **284**. The flotation devices **284** may be foam materials coupled along the upper edge of the curtain **212** by rope or string **286** attached to the attachment sleeves **278, 280**. Alternatively, the rope or string **286** can be attached to the curtain **212** via grommeted eyelets incorporated therein. As another alternative, the flotation devices **284** could be retained inside of sleeves formed along the upper edge of the curtain **212**. It is to be noted that the curtain **212** may include periodic perforations therein to allow a portion of the water **218** and waves to pass therethrough.

In operation, the flotation devices **284** hold the upper edge of the curtain **212** at the level of the water **218** with minimal sagging. During calm conditions, this means that the attachment sleeves **278, 280** and curtain **212** are relatively low with respect to the first and second support members **224, 226**. When a wave approaches, the flotation devices **284** rise with the wave pulling the curtain **212** upward as well. The attachment sleeves **278, 280** slide upwardly on the respective support members **224, 226**, allowing the curtain **212** to freely rise so as to be in position to attenuate the wave. Because the entire curtain **212** rises and falls with the attachment sleeves **278, 280**, the curtain weights **90** that are employed in the first embodiment are not used in the third embodiment.

Referring again to FIG. 10, it is noted that additional curtains **212** can be attached to the dock **208** between adjacent pairs of support members. In this case, a single attachment sleeve could be used to attach adjacent ends of two curtains to the same support member. As with the prior embodiments, each curtain **212** may be fabricated of a substantially non-metallic material having energy absorbing qualities, such as neoprene.

While specific embodiments of the present invention have been described, it will be apparent to those skilled in the art that various modifications thereto can be made without departing from the spirit and scope of the invention as defined in the appended claims.